CIA/PB 131632-69

UNCLASSIFIED- SOVIET BLOC INTERNATIONAL GEOPHYSICAL YEAR INFORMATION

JUNE 5 1959

23-69

(70)

PB 131632-69

INFORMATION ON SOVIET BLOC INTERNATIONAL GEOPHYSICAL COOPERATION - 1959

June 5, 1959

U. S. DEPARTMENT OF COMMERCE
Office of Technical Services
Washington 25, D. C.

Published Weekly
Subscription Price $12.00 for the Series

INTERNATIONAL GEOPHYSICAL COOPERATION PROGRAM--
SOVIET-BLOC ACTIVITIES

Table of Contents | Page

I. ROCKETS AND ARTIFICIAL EARTH SATELLITES

Soviet Astronomer Discusses Difficulties in Sighting Mechta

The difficulties and possibilities of sighting Mechta, the first cosmic rocket and also the first artificial planet of the solar system, which was launched by the USSR on 2 January 1959, are considered in a Priroda article by Prof N. S. Yakhontova of the Institute of Theoretical Astronomy, Academy of Sciences USSR (Leningrad).

The study of small planets moving in the regions near the Sun and the Earth are especially of interest now in connection with the launching of the cosmic rocket. All of the planets of this group are very small (almost all are less than 1-2 kilometers in diameter) and, therefore, very few are discovered; they are discovered only because they come very near the Earth from time to time. The principal mass of these small planets forms a narrow ring between the orbits of Mars and Jupiter. Discoveries in recent decades show that there are also planets which can go far out beyond these limits. Small planets belong to a wide complex of small bodies moving in interplanetary space in the limits of the Solar system. Hence, comets, small planets and meteorites, meteor showers, and the cloud of meteoric matter visible from the Earth as Zodiacal light are related. All are genetically connected but have different physical structures and a different character of motion.

The rocket Mechta moves around the Sun in an almost circular orbit lying between the orbits of the Earth and Mars, thus becoming a member of that vast family of small planets.

Mechta, launched on 2 January 1959, entered into its heliocentric orbit on about 7-8 January. It passed its perihelion on 14 January, whereby its distance from the Sun was less than one astronomical unit, 0.979, and the distance from the Earth to the Sun at the time was 0.984, i.e., it entered inside the Earth's orbit. Owing to the negligible eccentricity at aphelion, the rocket will pass out of the limits of the Earth's orbit (its aphelic distance was 1.31 astronomical units) but will remain inside of Mars' orbit. Its average distance is 1.14 astronomical units, which corresponds to a revolution period of approximately 15 months. Since the time of four revolutions of the rocket closely approaches the time of five revolutions of the Earth, the rocket will draw near the Earth every 5 years.

The problem of sighting the Soviet cosmic rocket is considered similar to that of sighting a small planet. Moving mainly under the influence of the attraction of the Sun, small planets experience the disturbing action of the larger planets and, in the first place, of their nearest massive neighbor, Jupiter.

To be able to observe a known small planet for a sufficiently long time, these disturbances must be calculated. Recently, high-speed computers have been employed in such calculations. The Institute of Theoretical Astronomy, using the BESM computer, in 1957 calculated the ephemerides of a group of planets. The following program was used:

> The elements of the small planets and the coordinates of large planets for the entire time of integration are fed into the machine. According to the elements of the small planets, the machine itself calculates the initial coordinates, performs the integration and "finds" the period of visibility of the planets (approximately the moment of opposition), and calculates the ephemerides. Completing the calculation of ephemerides, the machine continues the integration further, and the whole process is repeated again for the following year. In calculations according to this program, for fulfilling 260 steps of integration with the calculation of disturbances from three planets -- Jupiter, Saturn and Earth, and the calculation of the ephemerides for 5 years only 4 1/2 minutes were required for each small planet.

Prof Yakhontova emphasizes that the bases of all calculations are observations. The integration of equations and the calculation of disturbances can give good results only if well determined elements are available, and the elements of orbits can be determined only directly from observations. Therefore, calculations must always be combined with observations.

As to the possibility of calculating the ephemerides of the cosmic rocket at the time of its future approach to the Earth, Prof Yakhontova says that to accurately predict the position of the rocket 5-10 years hence would be very difficult. This would be similar to searching for small planets (asteroids). However, only those asteroids whose diameter is more than one kilometer can be observed with the most powerful of today's telescopes. But small asteroids are evidently fragments of some large body and, therefore, are irregular in shape, have a rough, spotted surface, and reflect a total of about 5-15 percent of the sunlight striking them, while the coefficient of reflection of light from a rocket is many times larger. The development of engineering is proceeding at such a tempo that it is fully possible that in 5 years, we may possess the means which will make it possible to observe the Soviet rocket.

"The creation of the first artificial planet has enormous value. It showed that a body created by the hands of man can be imparted a velocity which will transform this body into a member of the solar system. Changing the initial conditions of the launching, we can create planets with such trajectories as we need for solving different problems of practical or theoretical value." ("The Cosmic Rocket -- The First Artificial Small Planet," by Prof N. S. Yakhontova, Institute of Theoretical Astronomy, Academy of Sciences USSR, Leningrad; Moscow, Priroda, No 4, Apr 59, pp 5-8)

Study on Brightness Fluctuations of Artificial Earth Satellites

A brief account of the influence of the fluctuation of the brightness of artificial earth satellites on their optical observation gives the following information.

All earth satellites which are not stabilized by gyros at the moment they move out of the launching path into orbit show, as a result of the rapid changing cross section of their illuminated surface, a fluctuation of their apparent brightness, which can amount to several orders of magnitude. For this reason, even very bright satellites can become invisible periodically. The satellite observers were not prepared at first for this light variation and had to change their methods of observation in many cases. Experiences gained thus far have shown that the light fluctuations of artificial earth satellites can affect optical observations quite differently. If the period of the rotation of the satellite is short (a few seconds), the satellite can be located early and tracked for a long time because of the blinking effect. This affords a longer period of time for the taking of measurements and greatly increases the amount of data obtained. The carrier rocket of Sputnik III showed such a favorable behavior. The period of light fluctuation during the entire 200 days of orbiting amounted to about 8-9 seconds. The path of this carrier rocket recorded on a series of 19 photographs taken in Potsdam on 10 August 1958, when plotted on a star chart, clearly shows the accuracy with which the photographic method reveals the apparent path of the satellite when the period of light fluctuations is shorter than the exposure time of the photographs. When the period is known, each brightness maximum shows both the position in the sky and the time, without the time having to be measured at each maximum, which is technically impossible. The period can be determined by a measurement of the times for the first and the last maxima and by counting the number of maxima between them.

In the case of the passage photographed on 10 August 1958, the time of the first maximum was determined as $22^h\ 33^m\ 15.4^s$ and of the last maximum as $21^h\ 41^m\ 10.5^s$, and the number of maxima between these two was found to be 52, so that the period of brightness fluctuations (half period from a physical point of view) amounted to 9.14^s.

The 19 photographs recorded 48 maxima; thus, during this single passage, 48 individual positions of the carrier rocket were determined; this is the maximum yield obtainable with the instruments in use.

Conditions were much less favorable for Sputnik III itself. First of all, its brightness was only of the 4th magnitude and, secondly, the period of the rotation of the body was much longer than the average exposure of a photograph. In the summer of 1958, it amounted to 140 seconds; in November 1958, it was 24 seconds shorter for a time; and in February 1959, it was about 50 seconds. Just how unfavorable the long period of light variation of Sputnik III can be for optical observations is shown by measurement data of the East German observation network for the period of flight of the carrier rocket (15 May 1958 to 3 December 1958). During this period, the measurements of Sputnik III and the carrier rocket were on a ratio of 1:10. ("The Influence of the Brightness Fluctuations of Earth Satellites on Their Optical Observation," by U Guentzel-Ligner and G Boettger; Berlin, Wissenschaft und Fortschritt, No 4, Apr 59, pp 156-157)

II. UPPER ATMOSPHERE

Soviet Scientist Says Mars' Moons Are Artificial Satellites

A new and interesting theory concerning the nature of Mars' satellites was set forth by I. S. Shklovskiy, Doctor of Physicomathematical Sciences, in an interview with a representative of Komsomolskaya Pravda.

After briefly stating what modern science knows concerning the satellites, Shklovskiy unfolded his theory.

Mars' satellites, Phobos and Deimos, differ from those of other planets of the solar system, first, because of their extremely small dimensions (no other planet, excluding the Earth and its artificial earth satellites, has such small moons) and, second, their extreme nearness to their primary. A completely unique phenomenon in our solar system is the fact that Phobos' revolution period is shorter than the axial rotation period of its primary. All cosmogonic hypotheses which have supplanted one another cannot explain the origin of such singular satellites. If, for example, it is assumed that these asteroids were accidentally trapped by Mars, then it is incomprehensible why they move in an almost circular orbit lying precisely in the equatorial plane.

There is still another astonishing difference between the Martian satellites and all of the other satellites in the solar system. Observations conducted in 1945 showed a great departure in the theoretically calculated position of Phobos from its actual position. This variation was very large. During several decades, Phobos moved ahead of its calculated position a whole 2 1/2 degrees.

At one time, Phobos accelerated its motion and approached the surface of Mars. This, says Shklovskiy, is precisely what occurs in the case of artificial earth satellites -- they are braked by atmospheric resistance, drop lower, but at the same time they accelerate their motion.

"The changes in the nature of the motion of Phobos are so large that it may be safely said we are witnessing the slow demise of a celestial body. In the course of about 15 million years, Phobos will fall on Mars."

Two reasons are forwarded today in foreign scientific literature as to the cause of this braking. First, that it is caused by the atmospheric medium surrounding the planet. But if this is so, says Shklovskiy, why does it not affect the other moon, Deimos, as well? The second cause, may be tides in the solid envelope of Mars. The first reason found no support in recent studies, and the second almost none. However, there are other possible reasons. The possibility of the existence of a magnetic field around Mars must be admitted. But, Shklovskiy says, his own calculations have rejected this possibility as well.

Approved For Release 1999/09/08 : CIA-RDP82-00141R000200700001-5

Finally, it is impossible to exclude the theory that the acceleration in the motion of Phobos occurs according to the laws of celestial mechanics because of the influence of the attraction of Deimos, the Sun, and other planets. However, all of these reasons must, and this again was also shown by calculations, have a stronger influence on Deimos and not on Phobos. Actually, the reverse occurs.

Thus, Shklovskiy concludes that none of the "natural" processes could explain either the origin of the Martian moons or the peculiarities in the motion of Phobos.

Having analyzed and rejected all the conceivable reasons for the braking of Phobos, he arrived at the following conclusion: "It is probable that the braking of the upper and extremely rarefied layers of Mars' atmosphere play a deciding role here. But in order for this braking to be so considerable in view of the extreme rarefaction of Mars' atmosphere at such an altitude, Phobos must have a very small mass, and this also means an average density approximately one thousandth less than the density of water.

"But can an entirely solid body have so small a density, probably less than the density of water? Definitely, no. It is possible that Phobos is not solid, but is some cloud of very fine, widely separated dust particles. But such a cloud, calculations show, would be scattered over the entire trajectory and be converted into something similar to the great ring of Saturn. Also, there is only one manner of combining the requirements of the solidity and stability in Phobos' shape and its very insignificant average density. It is necessary to suppose that Phobos is empty and void inside, somewhat like a tin from which the contents have been removed.

"Now can an artificial cosmic body be empty? No and No. Consequently, Phobos is an artificial satellite of Mars. Do the peculiarities in the properties of Deimos, although less striking than in Phobos, make it possible to suppose that it too is of artificial origin?"

The rather considerable dimensions of Mars' artificial satellites and their masses, which are perhaps 100 million tons or more, says Shklovskiy, are no bar to the idea of their artificial origin. The creation of such satellites is not an insoluble engineering problem for intelligent beings. There is not any doubt that in future centuries such satellites will also be created around the Earth.

Shklovskiy says that Mars' nature today is comparable to that of a plateau 18 kilometers high on Earth. There is almost no oxygen in its atmosphere. He is convinced that no highly developed form of life exists there now. Perhaps there are only the simplest forms of plants like fungus, moss, and lichens. But evidently 2 million or 3 million years ago, the situation was otherwise. Many astronomers think that then there was oxygen in Mars' atmosphere and extensive seas and oceans upon its surface. It is probable that intelligent beings also appeared on Mars at the time who reached a high level of culture. Shklovskiy believes that at one stage of their development, it was necessary for them to go beyond the limits of their own planet. As gravity on Mars is considerably less than on Earth, the realization of cosmic flight was considerably easier.

Shklovskiy believes that it is certainly possible to prove that Mars' satellites were of artificial origin. The best confirmation will be the landing of astronauts from Earth upon them. But this, according to the most daring prediction, cannot be expected in one decade. Considerably more realistic is the launching of a rocketsonde equipped with scientific apparatus in the region of Mars. With its aid, important information concerning the nature of Mars' satellites can be transmitted to Earth.

Observations from the Earth can also explain their nature. Thus, a careful study of changes in their brightness would be extremely important. As is known, asteroids whose dimensions exceed the dimensions of Mars' satellites, as a rule, are not round in form, but simply odd fragments of rock. Their rotation in space around their center of gravity causes a sharp periodic change in brightness. If, for example, the brightness of Mars' satellites proves to be constant -- which will confirm their spherical form -- it will be an important confirmation, he says, of his hypothesis.

Somehow or other, says Shklovskiy, the theory concerning the artificial origin of Mars' satellites will not remain a theory for long. In the very next years or, at the latest, decades, either it will be confirmed by new absolutely conclusive facts or other explanations of the puzzling "oddities" in the character of Mars' satellites will be found. ("Artificial Satellites of Mars, Interesting Hypothesis of a Soviet Scientist"; Moscow, Komsomol'skaya Pravda, 1 May 59, p 6)

III. METEOROLOGY

Local Acoustical Method Used in Determining Air Temperatures

Measurements of air temperature by the usual methods, using transducers the parameters of which depend on temperatures (bimetals, thermistors, resistance thermometers, etc.), are distorted by radiation errors, which increase with altitude. This is tied in with the fact that these methods are, in a certain sense, indirect, i.e., the temperature of the body is determined, and not the temperature of the air itself. The Soviet RZ-049 radiosonde, with bimetallic temperature transducers, gives a radiation error which is almost doubled with each 5-6 kilometer increase in altitude. The use of resistance thermometers established in meteorological rockets is further complicated by such factors as the resistance of the air, the speed of the rockets, the angle of attack, etc.

A method for determining air temperatures in which it is possible to exclude radiation error and to decrease lag errors is the acoustical method. It is known from observations on the propagation of sound waves from explosions in the air that it is possible to determine temperature according to the velocity of the sound. However, this is an integral method and requires at the very least several observation points, is complex in its organization, and is insufficiently accurate.

The measurement of temperature in the free atmosphere according to the velocity of sound is possible by using the local method; that is, simultaneously raising a receiver and a source of sound which are close to each other into the air. The local acoustical method can be used to explain the fine structure of the temperature field in the atmosphere, more correctly establish errors in other instruments (radiosondes in particular), to determine the daily variation of temperature and the influence of the Sun on the temperature of the lower and middle stratosphere.

The accustical method is a direct method, inasmuch as the thermometric body is absent and the measured value (the velocity of sound in the air) is proportional to the mean square velocity of the motion of the molecules.

The acoustical method of measuring the temperature of the air is based on the known relationship of the velocity of sound to the temperature of the air. The molecular weight of the air up to about 100 kilometers, where atomic oxygen occurs, can be considered as constant, and the value of heat capacity depends very little on the temperature. In the absence of molecular absorption of sound, can also be considered as a constant value. The effect of humidity on the velocity of sound at altitudes over 5 kilometers is negligibly small. The increase in the absorption of sound and the decrease in the resistance of radiation in rarefied gases plays an important role. The upper limits for the applicability of the local acoustical method, using frequencies of approximately tens of kilocycles is equal to about 50 kilometers.

The phase method, with continuous radiation of sound, was selected for temperature measurements of the air, according to the velocity of sound. In the acoustical method, the measurement of temperature is reduced to a determination of the time of passage of the sound over the distance between two points.

One of the methods of acoustically measuring air temperature is the work being conducted in the Institute of the Physics of the Atmosphere, Academy of Sciences USSR.

One of the first versions of the acoustic thermometer developed in the Geophysics Institute of the Academy of Sciences USSR was tested in 1954.

Transducers in the electrodynamic circuit serving as the source and receiver of the sound, are fastened, one on each end of a metal bar 1.5 meters long. The apparatus is lifted by a bunch of hydrogen-filled balloons. The frame with the radiator and receiver is positioned 12 meters below the instrument container and 30 meters below the balloons. A Manuilov (MZM) meteorgraph and an RZ-049 radiosonde, with a motor instead of a propellor, are lofted with the acoustical instrument.

It was found that at altitudes where the ascending speed drops and the ventilating effect decreases, overheating of the radiosonde and the meteorgraph occurred because of solar radiation. The effect of the wind may have been the reason for the spread in the readings of the acoustical thermometer. During the balloon ascent of the acoustical thermometer, the motion of the system relative to the air can show itself for the following reasons: because of the swinging of the receiver-radiator system;

because of the difference in the gradient of the wind speed at the points the frame and the balloons are located; and because of the finite time of establishing the velocity of the entire system being raised in the air mass.

Later versions of the acoustic thermometer produced by the Institute of the Physics of the Atmosphere, Academy of Sciences USSR, are so designed as to lessen the effects of the wind.

("Local Acoustical Method of Measuring the Temperature of the Air," by M. O. Mordukhovich, Institute of the Physics of the Atmosphere, Academy of Sciences USSR; Moscow, Izvestiya Akademii Nauk SSSR, Seriya Geofizicheskaya, No 3, Mar 59, pp 480-488)

Study on Atmospheric Flow Around Mountains

A description is given of an investigation of a three-dimensional problem of the atmospheric flow around large mountain obstacles in a rectangular, rectilinear system of coordinates (i.e., without taking the sphericity of the earth into account). The motion is assumed to be steady and adiabatic and the atmosphere, compressible and baroclinic. The linear problem is solved by the long-wave method.

The conditions of quasi-geostrophicity are not applied, and an attempt is made to obtain a strict determination of the original system of equations. This affords the possibility of explaining the influence of the hypothesis of quasi-geostrophicity and of obtaining an answer to the above problem. Boundary conditions at the earth's surface are taken into account in such a way as to preserve the effects of both the flow over and the flow around the mountain barrier. ("Calculation of the Geostrophicity in a Three-Dimensional Problem of the Flow Around Mountains," by G. P. Kurbatkin, Institute of Applied Geophysics, Academy of Sciences USSR; Moscow, Izvestiya Akademii Nauk SSSR, Seriya Geofizicheskaya, No 4, Apr 59, pp 580-592

Study on the Stability of Planetary Movements of the Atmosphere

On the assumption that most foreign works on the planetary circulation of the atmosphere are limited to a qualitative agreement between individual solutions of linearized equations and the characteristic properties of actual barimetric centers, this article follows several other Soviet authors in avoiding this limitation, and thereby finds it possible to apply the theory to a quantitative prognosis of the pressure field. Inasmuch as pressure is studied on a world-wide scale, the investigation of the atmospheric movements is made on the basis of a two-level spherical model.

In the light of the criterion advanced here, an instability of the atmosphere is encountered less frequently than might be expected according to the theory of Phillips (Tellus, Vol 6, No 3, 1954). The latter made use of local values of the vertical gradient of velocity, whereas here the more expeditious vertical gradient of the index of circulation is used.

The results obtained in a prognosis for 9 December 1957 (700 and 300 millibar pressure field, latitudinal interval 5 degrees, longitudinal interval 15 degrees) clearly reflect the evolution and movement of large-scale cyclones. The movement of a cyclone out of the Stockholm area into the Leningrad area and the drop of pressure at the center were accurately forecast. The evolution of a cyclone in the Iceland area was also successfully predicted in this one-day prognosis.

The results were not as good in the Western Hemisphere. In the territory of the US, the barometric formations were displaced somewhat toward the east. Individual inaccuracies could be explained partially on the basis of the small number of terms of a series and by the larger intervals of latitude and longitude. A further refinement of the method should, accordingly, involve the introduction of a greater number of terms of a series of spherical functions and smaller intervals of the horizontal coordinates. ("On the Stability of Planetary Movements of the Atmosphere," by M. B. Galin, Institute of Applied Geophysics, Academy of Sciences USSR; Moscow, Izvestiya Akademii Nauk SSSR, Seriya Geofizicheskaya, No 4, Apr 59, pp 570-580)

IV. GEOMAGNETISM

Observations of the Geomagnetic Field and Earth Currents in the USSR

The intensity of the Earth's magnetic field in a given moment and at a fixed place consists of several components. Among these are the short-period portion of the field fluctuations. These can be separated into two forms: large pulsations reaching tens of gammas in northern latitudes, and micropulsations with amplitudes from one thousandth of a gamma up to units of a gamma and with periods from several tens of seconds up to several minutes.

Micropulsations have the attention of all geomagnetologists at present. The great value of the investigation of a new region of the geomagnetic field, rapid micropulsations, was emphasized in the working group on geomagnetism at the Fifth Assembly of the Special Committee of the IGY held in Moscow last year.

The Institute of the Physics of the Earth imeni O. Yu. Shmidt, Academy of Sciences USSR, heads the work on observations of micropulsations of the Earth's electromagnetic field in the USSR. For fulfilling the IGY program in this field, the institute, during 1956-1957, built new geomagnetic stations and assisted in the organization of such stations in other places -- in the Crimean Astrophysical Observatory and in Dusheti (Georgian Academy of Sciences). Five complex stations intended for observations of short-period variations of both the geomagnetic field and earth currents were operating in the USSR at the beginning of the IGY. Stations in Lovozero, Borok, Crimea (Mangush, Alushta), and Dusheti (near Tbilisi) are arranged in a meridional direction from 68 to 42 N, and the Kamchatskaya Station which is located at a longitudinal distance of 120 degrees from the first group of stations. This makes it possible to study the distribution of short-period variations in both latitudinal and longitudinal directions. All of the above-mentioned stations are equipped with fluxmeter apparatus developed in the Institute of the Physics of the Earth, Academy of Sciences USSR, and also standard apparatus for the simultaneous registration of earth currents.

The principle of the fluxmeter stations is as follows: A large cable coil from 100 to 200 millimeters in diameter is connected with a fluxmeter (measurer of changes in the magnetic flux). During changes in the Earth's magnetic field, the flux through this cable coil changes. As a result of the coil's large dimensions, even insignificant changes in the field give sufficient magnitudes of variation of the magnetic flux for their registration by a sensitive fluxmeter. A beam of light from a lamp falls on a mirror linked with the fluxmeter frame, is reflected by the mirror, and gives an image of a slit on the scale of a self-recorder. Displacement of the fluxmeter frame under the action of changes in the magnetic flux is registered on a moving photographic film, and thus changes in the Earth's magnetic field are recorded.

The cable coil is set horizontally in the earth at a depth of about 70 centimeters, at a distance of several hundred meters from the point where the recording apparatus is situated. The horizontal coil is intended for registering rapid changes in the Z-component of the Earth's magnetic field. Near such coils, electrodes for recording earth currents are placed in two mutually perpendicular directions (north-south and east-west). Instead of a fluxmeter, the usual mirror galvanometer with a short natural period is used. Such equipment, with which short-period variations of the geomagnetic field and earth currents are registered simultaneously, and, in the course of a day, with a film speed of 90 millimeters per hour, are installed in all of the above-named complex stations. In addition to this, high-speed recordings lasting 20 minutes are taken several times a day. At these times, the tape moves at a speed of 0.5 millimeters per second, making it possible to investigate the fine structure of short-period variations of the geomagnetic field.

It would be very important to study rapid pulses of the horizontal component of the geomagnetic field, but to do this, it is necessary to build large, vertically arranged coils or frames. However, very large vertical, perfectly immobile frames would be very difficult to produce. Also of interest would be an explanation of space-time changes in the vertical component of the short period portion of the spectrum of geomagnetic variations. To do this, two identical horizontal coils would have to be placed at some distance from each other and the changes in the gradient of the field intensity between them recorded.

The Lovozero, Borok, and the Petropavlovsk stations are now solving this problem. Only the first two at present have three-component installations. The Borok Central Geomagnetic Station has at its disposal two buildings intended for recording geomagnetic phenomena and for the accommodation of experimental equipment. The magnetic pavillion is built of nonmagnetic materials, and thermal insulation is provided in the form of a perimetric corridor around the entire building and hot water heating using brass pipes.

A room with deep foundations for the installation of the magnetostatic apparatus occupies only 140 square meters. The external walls of this pavillion were used for installing the vertical cable frames. The plane of the pavillion's walls coincides with the direction of the north-south and east-west geomagnetic coordinates. Therefore, the frames situated in these walls make it possible to record changes in the horizontal components, ΔX and ΔY, of the field. One horizontal coil, equal in sensitivity to the vertical frames, is installed with the latter in the walls. Each of these induction loops is connected with a fluxmeter, and all light signals are reflected on one 200-millimeter wide tape on which the rapid pulsations of the 3 mutually-perpendicular components of the geomagnetic field are synchronously recorded.

Three-component analyses of short period variations of the geomagnetic field were performed on this apparatus for the first time in the world.

For studying the spatial gradients of the Z-components, at each of the Soviet stations, three horizontal coils were arranged on the vertices of an isosceles right triangle the length of whose legs is equal to one kilometer. These coils, with a diameter of 70 meters, are connected with a fluxmeter, have similar sensitivity, and make it possible to observe changes in the Z-components of short-period variations with time and at a fixed place on the Earth's surface.

Thus, various fluxmeter devices ensuring full analysis of the short-period portion of the Earth's geomagnetic and geoelectric fields are installed in stations of the Institute of the Physics of the Earth.

Recordings of pulsations of the geomagnetic field's Z-component have been made since 1 June 1957. Their processing has already given interesting results. Also very promising is the analysis of the recordings of the three-component installation in Borok, where it was ascertained that full vector pulsations rotate differently at different times. They sometimes rotate with a period of several tens of minutes, but most frequently, they oscillate in a fixed direction.

Recordings of variations of the Z-component in gradient installations made it possible for the first time in the world to discover changes in the gradient of Z-variations with time. It was shown that in rapid oscillations and with large amplitudes, the form and the amplitude of pulsations are already changed in a distance of one kilometer. The unique fluxmeter installations in Borko, together with other USSR stations make it possible to solve a number of important problems on terrestrial magnetism. On the basis of the recordings of these stations it will be possible to study changes in the diurnal variation of short-period variations at different stations, to note the appearance of simultaneously originating pulsations in the entire USSR territory, to explain the connection of geomagnetic pulsations with variations in earth currents, and finally, to solve the problem of the distribution of electrical conductivity of the upper parts of the Earth's crust. A comparison of all of these data with ionospheric phenomena, aurorae, and solar activity makes it possible to investigate the relationship between very weak changes in the geomagnetic field and also very insignificant changes in the ionosphere and in the Earth's outer atmosphere.

During the Fifth IGY Assembly in Moscow, a number of foreign scientists, among whom was Prof S. Chapman, its president, visited the Borok station. Prof Chapman commented very favorably on the quality of the equipment and the significance of work being done. He is quoted as saying,... "The most interesting innovations are the two vertical coils placed around two walls of a large building of the station, turned correspondingly to the east and north. As far as I know, measurements with a vertical coil are not made in any other country. These recordings are very interesting and useful for comparison with recordings obtained from coils set in a horizontal plane and with recordings of earth currents. By means of investigations of such pulsations, we will learn more concerning the electrical and magnetic conditions in the regions high over the Earth in which [artificial] satellites travel..."

Very shortly the magnetometric group of the Institute of the Physics of the Earth will finish processing the first recordings of the gradient and three-component installations. The results of the processing will contain new information on the Earth's magnetic field. ("Observation of Rapid Pulsations of the Geomagnetic Field and Earth Currents," by Prof A. G. Kalashnikov, Institute of the Physics of the Earth Academy of Sciences USSR, Moscow; Moscow, Priroda, No 4, Apr 59, pp 59-62)

Study on the Electrical Field of a Cable Near Heterogeneities in the Earth

On the basis of a calculation of the influence of the heterogeneities of the Earth on the field of a rectilinear cable of infinite length, the following conclusions are drawn regarding the intensity and character of anomalies:

1. In the case of a shallow vein (in relation to the wave length in the ground), the anomaly of the field modulus is on the order of several tens of percentiles, and the anomaly of the field phase is on the order of several tens of degrees.

2. As the distance from the vein increases, the anomaly of the field attenuates rapidly, the modulus anomaly attenuating more quickly than the phase anomaly. On the average, the width of the anomaly is on the order of 0.1-0.2 of the length of the wave in the earth.

3. With an increase of the depth of the location of the vein, the intensity of the anomaly decreases, but the width of it increases. ("The Influence of the Heterogenieties of the Earth On the Field of a Rectilinear Cable of Infinite Length," by V. I. Dmitriyev, Institute of the Physics of the Earth, Academy of Sciences USSR; Moscow, Izvestiya Akademii Nauk SSSR, Seriya Geofizicheskaya, No 4, Apr 59, pp 621-623)

V. SEISMOLOGY

Study on the Dispersion of Love Waves During Nearby Earthquakes

Since seismograms of several seismic stations in the Caucasus indicate the occurrence of surface waves in the case of nearby earthquakes, a study was made of the surface waves of ten earthquakes in the Dzhavakhetskiy Khrebet Mountains recorded by the seismic stations at Tbilisi and Yerevan. An analysis of the seismograms of these stations shows that, when there is a good recording of the surface waves, the intensity of the volumetric waves recorded by Golitsyn and Kirnos instruments) is insignificant, and their occurrence is not clearly indicated. Investigations have shown that such a condition exists when earthquakes with surface focuses occur.

Love waves (Love, A. E. I., Some Problems of Geodynamics, Cambridge University Press, 1911) clearly recorded on seismograms of the majority of earthquakes in the Dzhavakhetskiy Khrebet Mountains were separated from the surface waves and are classified as Love surface waves for the following reasons:

(1) these waves are more strongly recorded by the horizontal seismograph, the pendulum axis of which is close to the direction toward the epicenter;

(2) they are not recorded by vertical seismographs (At the Tbilisi station, the sensitivity of the vertical and horizontal seismographs are equal; at the Yerevan station, the sensitivity of the horizontal is greater than that of the vertical. At these stations there are, for other earthquakes with similar energies, recordings on which the Rayleigh waves are clearly indicated by the vertical component.);

(3) the horizontal component determines the direction perpendicular to the direction toward the epicenter; and

(4) the recording of these waves begins right after the onset of the S waves.

The ten earthquakes studied occurred in the period 2 December 1953-3 April 1957; the epicenters were 126-150 kilometers from the Yerevan station and 85-102 kilometers from the Tbilisi station.

On the basis of the rate of propagation of the transverse waves (2.6 km/sec for the sedimentary layer; 3.4 km/sec for the granite layer; and 4.0 km/sec for the basalt layer), these three layers of the earth's crust in the Verkhney Kartil region have the following thicknesses: 5-7 kilometers for the sedimentary layer; 20.5 kilometers for the granite layer; and 24 kilometers for the basalt layer.

The group velocity of the Love waves was also determined from seismograms of the two stations, and the results are plotted. ("A Study of the Dispersion of Love Waves During Nearby Earthquakes," by D. I. Sikharulidze, Institute of Geophysics, Academy of Sciences Georgian SSR; Moscow, Izvestiya Akademii Nauk SSSR, Seriya Geofizicheskaya, No 4, Apr 59, pp 593-597)

VI. OCEANOGRAPHY

Study of Sea Currents With Variable Vertical Exchange

Earlier articles by the author (DAN, Vol 109, No 2, 1956; Tr. Inst. okeanologii AN SSSR, No 19, 1956; DAN, Vol 113, No 1, 1957) presented a principal solution of the problem of determining a steady flow resulting from irregular winds in an inland sea with an arbitrary bottom relief. Here, the author generalizes the theory for the case in which the coefficient of vertical exchange varies in the horizontal directions, depending on the velocity of the wind, the depth of the sea and the coriolis parameter. In the earlier works, no calculation was made of the coriolis force, i.e., only the case of the shallow sea was considered. ("A Generalization of the Classical Theory of Steady Sea Currents for the Case of a Variable Coefficient of Vertical Exchange," by A. I. Fel'zenbaum, Institute of Oceanology, Academy of Sciences USSR; Moscow, Doklady Akademii Nauk SSSR, Vol 125, No 4, Apr 59, pp 779-781)

VII. LATITUDE AND LONGITUDE

Soviet Latitude Stations

The Moscow Latitude Station, along with other stations and observatories, is working according to the IGY program. Using a zenith telescope, the station conducts observations on changes of geographic latitude.

It is known that the Earth's axis of rotation does not occupy an unchanging direction in space. As a result, the poles of the celestial sphere also change their position, describing circles among the stars. During recent years, scientists have compiled maps of the motion of the poles. It has been established that the North Pole moves in a counter-clockwise direction describing a complex spiral curve around its mean position. The largest amplitude of oscillation, 26 meters, was noted in 1952.

Changes in the position of the poles, in the opinion of scientists, results from a whole series of reasons connected with the shape of the Earth, its internal structure, and the displacement of masses on the surface and inside of the planet.

The first results have been obtained in the Moscow station which describe the movement of the pole in 1958. The observatory worked out a program of observations which has been adopted by all latitude stations in the USSR. This ensures obtaining materials for studies of both periodic and secular changes of latitude. ("Why Latitudes Change"; Moscow, Izvestiya, 13 May 59, p 6

VIII. ARCTIC AND ANTARCTIC

Nothern Station Photographs Auroras

At the end of the last polar night, the northern scientific station of the Institute of Physics of the Atmosphere, Academy of Sciences USSR, which is located on Kola Peninsula, had completed an extensive cycle of work under the IGY program. The scientists have photographed the last aurora of the polar night.

M. L. Bragin, a staff member at the station, spent the fourth polar night in the Arctic region. He has a collection of many unique photographs of auroras. Until recently, auroras had not been photographed on a movie film. However, after readjusting the camera, it was possible to take a large number of motion-picture views of auroras. ("The Last Aurora"; Moscow, Sovetskaya Rossiya, 1 Apr 59)

First Publication of Antarctic Geological Research Results

This article represents the first special publication of the results of the processing of Soviet Antarctic Expedition materials for the years 1956-1957. It is devoted to an extremely rare group of late pre-Cambrian metamorphic rocks of green schist phases, encountered for the first time in the central sector of East Antarctica, where hitherto only crystalline schists and gneisses of the granulitic phase of metamorphism had been known to exist.

These particular studies were made in January 1957 by L. V. Klimov and P. S. Voronov, in the area of Mount Amundsen, 67 12 S and 100 44 E, and Mt. Sandow, 20 kilometers southwest of Mt. Amundsen, located at 67 22 S and 100 22 E.

The collected materials were processed in the Scientific Research Institute of Geology of the Arctic.

The 15-page article contains descriptions of various layers in cross-sections of Mount Sandow and Mount Amundsen and a petrographic description of metamorphic rocks found in this area. ("Late Pre-Cambrian Deposits of Mount Amundsen and Mount Sandow on Queen Mary Land in East Antarctica," by P. S. Voronov, L. V. Klimov, and M. G. Ravich; Moscow, Izvestiya Akademii Nauk SSSR, Seriya Geologicheskaya, No 3, Mar 1959, pp 3-18)

Preliminary Results of Antarctic Research Discussed

During the Fifth Assembly of the Special (International) Committee for Conducting the IGY, which met in Moscow during August 1958, some preliminary results of scientific work conducted during the IGY were discussed for the first time.

Among the subjects discussed at the assembly was the question of Antarctic meteorology. Even though the results of Soviet meteorological research in the Antarctic are, to some extent, preliminary in nature, they make it possible to draw a number of important conclusions. For example, an analysis of aerometeorological observations makes it possible to construct a new diagram for the regime of atmospheric circulation in that part of the world. Climatic central cyclones had formerly been recorded only above Weddell Sea, Bellingshausen Sea, and Ross Sea; now their formation above Davis Sea has also been established. For the first time, it was discovered that during the period of a whole year, atmospheric pressure in Antarctica lowered, and it is even lower in winter than in summer. In comparing the corresponding latitudes of the Arctic and Antarctic, it appears that in the Antarctic the troposphere is colder than in the Arctic, both in summer and in winter. All of these conclusions have considerable significance, as one cannot overestimate the influence of Antarctica on the climate and weather in all the countries of the Southern Hemisphere.

Some noteworthy conclusions have been made on the basis of geomagnetic observations conducted by members of the Complex Antarctic Expedition of the Academy of Sciences USSR. The scientists have detected considerable fluctuations of the field of earth currents in the Antarctic, sometimes reaching many hundreds of millivolt per kilometer. There have been instances when fluctuations of short duration were observed simultaneously in the Arctic, Antarctic, and temperate zones.

A symposium on glaciology was devoted to various problems of glaciation, especially in Antarctica. The Soviet Antarctic Expedition conducted its work along the coast of East Antarctica over a distance of 1,200 kilometers and over a distance of 1,500 kilometers from north to south. It was determined that the ice reaches a thickness of 2,500 meters in this area; large portions of the glacier bed (for example, along the profile Mirnyy-Pionerskaya) are below ocean level. A subglacial mountain elevation was discovered at a distance of 200-300 kilometers from the coast.

It was established that a characteristic feature of the antarctic glacier is the decrease in temperature with depth in the upper layers of the ice cover and the existence of a melting temperature at the glacier bed. Soviet scientists have solved a number of problems connected with the calculation of density, pressure, age, and speed of ice movement. The antarctic glacial cover is apparently maintained by cyclonic precipitation.

As a result of careful analysis, it is believed that the widely accepted hypothesis regarding the metachronic (metakhronnyy) character of the glaciation of Antarctica may be definitely refuted. It has been established that the glacial cover of this part of the world, as in the remaining parts, is gradually receding, even though more slowly elsewhere.

Since seismic methods are closely connected with glaciological studies, the two working groups held a joint symposium. As a result of work in Antarctica, more and more data are being collected on the structure of its glacial cover. It is interesting to note that all reports presented at the symposium lead to one conclusion, namely, that "Antarctica is not a single continent, but that a large part of it consists of islands, welded together by a general ice cover." ("A Great Contribution to International Scientific Cooperation"; Moscow, Priroda, No 2, Feb 1959, pp 65-72)

Drift Station Studies Marine Geology

Among the research activities conducted at the drift station Severnyy Polyus-7, the studies of marine geology proved especially valuable. The western slope of the Central Arctic elevation and parts of the Lomonosov range were explored in detail. Depth measurements made it possible to make considerable corrections on the existing bathymetric map of this area. Core samples up to 3 1/2 meters long were obtained from the ocean bottom. The study of these samples produced many new data on the conditions of ocean bottom sedimentation. A microscopic study was made of the core samples along a vertical line extending over their whole length, which helped to determine the trend of geological processes on the ocean bottom, the rate of accumulation of sediments, and their absolute age. For example, it was discovered that the 3 1/2-meter layer of sediments had accumulated on the ocean bottom during a period of 180,000-190,000 years. The geological history of the ocean during this period has been reconstructed in general terms. ("Last Days on the Drifting Ice Floe"; Moscow, Sovetskiy Flot, 7 Apr 59)

Staff Members of New Drift Station

V. Rogachev is the head of the new drift station Severnyy Polyus-8. Most of the scientific workers of the new station are experienced in arctic work. V. Nikonov, head of the aerological group, took part in two drifts of Severnyy Polyus-5 and Severnyy Polyus-6. N. Kotlomanov, in charge of radio communications, has spent some time in the Antarctic. L. Belyakov, oceanologist and astronomer, and L. Nikiforenko, mechanic, are also experienced polar workers. Together with these, there will be a number of young specialists, including G. Artem'yev and Ye. Podnebesnikov, actinometrists, and others. V. Porfir'yev, a young surgeon, and Yu. Vedeneyev, who formerly worked as a chef in the restaurant of Hotel Astoria, are flying to the Arctic for the first time. The crew of an AN-2 airplane will also be a component of the new drift station. ("Good Luck, Brave Men"; Moscow, Sovetskaya Rossiya, 4 Apr 59)

Academic Council Reports on Antarctic Activities

The conference of the Academic Council of the Arctic and Antarctic Institute ended on 25 March. Members of the Third Antarctic Expedition reported on the results of their work and the successful fulfillment of the IGY program. Reports were given by Ye. I. Tolstikov, chief of the Third Antarctic Expedition; M. Ye. Ostrekin, chief of the geophysical detachment; Prof V. A. Bugayev, chief of the aerometeorological detachment; and others, including P. D. Astapenko, weather synoptician, who wintered at the US station "Little America."

In conclusion, the Academic Council discussed the long-range plan for the Fifth Complex Expedition. ("Reports From the Conquerors of Antarctica"; Leningradskaya Pravda, 26 Mar 59)

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Approved For Release 1999/09/08 : CIA-RDP82-00141R000200700001-5